

Title: Primary Ciliary Dyskinesia GeneReview – Table 2
 Authors: Zariwala MA, Knowles MR, Leigh MW
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Table 2. Founder Variants by Ethnicity Reported in Individuals with Primary Ciliary Dyskinesia

Ethnicity (Specific Location)	Gene	DNA Nucleotide Change	Predicted Protein Change ¹	Reference Sequence
Amish &/or Mennonite ²	<i>DNAAF5</i>	c.2384T>C	p.Leu795Pro	NM_017802.3
	<i>DNAH5</i>	c.10815delT	p.Pro3606HisfsTer23	NM_001369.2
	<i>DNAH5</i>	c.4348C>T	p.Gln1450Ter	NM_001369.2
	<i>DNAI1</i>	c.48+2dupT	--	NM_012144.3
Ashkenazi Jewish ^{3,4}	<i>CFAP298</i>	c.735C>G	p.Tyr245Ter	NM_021254.3
	<i>DNAI2</i>	c.1304G>A	p.Trp435Ter	NM_023036.4
	<i>CCDC65</i>	c.877_878delAT	p.Ile293ProfsTer2	NM_033124.4
Asian ⁵	<i>DRC1</i>	c.1-3952_540+1331del27748-bp	--	NM_145038.4
Bedouin ^{6,7}	<i>DNAL1</i>	c.449A>G	p.Asn150Ser	NM_031427.3
	<i>RSPH9</i>	c.804_806delGAA	p.Lys268del	NM_152732.4
Dutch (Volendam) ⁸	<i>CCDC114</i>	c.742G>A	p.Ala248Thr	NM_144577.3
Faroe Islands ⁹	<i>HYDIN</i>	c.922A>T	p.Lys308Ter	NM_001270974.1
Irish Traveler ¹⁰	<i>CCNO</i>	c.258_262dupGGCC	p.Gln88ArgfsTer8	NM_021147.4
	<i>RSPH4A</i>	c.166dupC	p.Arg56ProfsTer11	NM_001010892.2
	<i>DNAAF4</i>	3549-bp large deletion	--	
Pakistani (United Kingdom)	<i>LRRC6</i>	c.630delG ¹¹	p.Trp210CysfsTer12	NM_012472.4
	<i>RSPH4A</i>	c.460C>T ⁷	p.Gln154Ter	NM_001010892.2
	<i>CCDC103</i>	c.383dupG ¹²	p.Pro129SerfsTer25	NM_213607.2
	<i>CCDC103</i>	c.461A>C ^{12,13}	p.His154Pro	NM_213607.2
Puerto Rican ¹⁴	<i>RSPH4A</i>	c.921+3_921+6delAAGT	--	NM_001010892.2
Polish ¹⁵	<i>CFAP300</i>	c.198_200delTTTinsCC	p.Phe67ProfsTer10	NM_032930.2

1. As predicted by [Mutalyzer name checker](#)

2. Ferkol et al [2013]

3. Austin-Tse et al [2013]

4. Fedick et al [2014]

5. Hijikata et al [2019]

6. Mazor et al [2011]

7. Castleman et al [2009]

8. Onoufriadis [2013]

9. Olbrich et al [2012]

10. Casey et al [2015]

11. Zariwala et al [2013]

12. Panizzi et al [2012]

13. Shoemark et al [2018]

14. Daniels et al [2013]

15. Ziétkiewicz et al [2019]

References

- Austin-Tse C, Halbritter J, Zariwala MA, Gilberti RM, Gee HY, Hellman N, Pathak N, Liu Y, Panizzi JR, Patel-King RS, Tritschler D, Bower R, O'Toole E, Porath JD, Hurd TW, Chaki M, Diaz KA, Kohl S, Lovric S, Hwang DY, Braun DA, Schueler M, Airik R, Otto EA, Leigh MW, Noone PG, Carson JL, Davis SD, Pittman JE, Ferkol TW, Atkinson JJ, Olivier KN, Sagel SD, Dell SD, Rosenfeld M, Milla CE, Loges NT, Omran H, Porter ME, King SM, Knowles MR, Drummond IA, Hildebrandt F. Zebrafish ciliopathy screen plus human mutational analysis identifies C21orf59 and CCDC65 defects as causing primary ciliary dyskinesia. *Am J Hum Genet* 2013;93:672-86.
- Casey JP, McGettigan PA, Healy F, Hogg C, Reynolds A, Kennedy BN, Ennis S, Slattery D, Lynch SA. Unexpected genetic heterogeneity for primary ciliary dyskinesia in the Irish Traveller population. *Eur J Hum Genet* 2015;23:210-7.
- Castleman VH, Romio L, Chodhari R, Hirst RA, de Castro SC, Parker KA, Ybot-Gonzalez P, Emes RD, Wilson SW, Wallis C, Johnson CA, Herrera RJ, Rutman A, Dixon M, Shoemark A, Bush A, Hogg C, Gardiner RM, Reish O, Greene ND, O'Callaghan C, Purton S, Chung EM, Mitchison HM. Mutations in radial spoke head protein genes RSPH9 and RSPH4A cause primary ciliary dyskinesia with central-microtubular-pair abnormalities. *Am J Hum Genet*. 2009;84:197-209.
- Daniels ML, Leigh MW, Davis SD, Armstrong MC, Carson JL, Hazucha M, Dell SD, Eriksson M, Collins FS, Knowles MR, Zariwala MA. Founder mutation in RSPH4A identified in patients of Hispanic descent with primary ciliary dyskinesia. *Hum Mutat* 2013;34:1352-6.
- Fedick AM, Jalas C, Treff NR, Knowles MR, Zariwala MA. Carrier frequencies of eleven mutations in eight genes associated with primary ciliary dyskinesia in the Ashkenazi Jewish population. *Mol Genet Genomic Med* 2015;3:137-42.
- Ferkol TW, Puffenberger EG, Lie H, Helms C, Strauss KA, Bowcock A, Carson JL, Hazucha M, Morton DH, Patel AC, Leigh MW, Knowles MR, Zariwala MA. Primary ciliary dyskinesia-causing mutations in Amish and Mennonite communities. *J Pediatr* 2013;163:383-7.
- Hijikata MK, Zariwala MA, Nykamp K, Inaba A, Guo TC, Yamada H, Truty R, Sasaki Y, Ohta K, Kudoh S, Leigh MW, Knowles MR, Keich N. Recurring large deletion in DRC1 (CCDC164) identified as causing primary ciliary dyskinesia in two Asian patients. *Mol Genet Genomic Med* 2019;7:e838
- Mazor M, Alkrinawi S, Chalifa-Caspi V, Manor E, Sheffield VC, Aviram M, Parvari R. Primary ciliary dyskinesia caused by homozygous mutation in DNAL1, encoding dynein light chain 1. *Am J Hum Genet*. 2011;88:599-607.
- Olbrich H, Schmidts M, Werner C, Onoufriadis A, Loges NT, Raidt J, Banki NF, Shoemark A, Burgoyne T, Al Turki S, Hurles ME; UK10K Consortium, Köhler G, Schroeder J, Nürnberg G, Nürnberg P, Chung EM, Reinhardt R, Marthin JK, Nielsen KG, Mitchison HM, Omran H. Recessive HYDIN mutations cause primary ciliary dyskinesia without randomization of left-right body asymmetry. *Am J Hum Genet* 2012;91:672-84
- Onoufriadis A, Paff T, Antony D, Shoemark A, Micha D, Kuyt B, Schmidts M, Petridi S, Dankert-Roelse JE, Haarman EG, Daniels JM, Emes RD, Wilson R, Hogg C, Scambler PJ, Chung EM, Pals G, Mitchison HM, et al. Splice-site mutations in the axonemal outer dynein arm docking complex gene CCDC114 cause primary ciliary dyskinesia. *Am J Hum Genet* 2013;92:88-98
- Panizzi JR, Becker-Heck A, Castleman VH, Al-Mutairi DA, Liu Y, Loges NT, Pathak N, Austin-Tse C, Sheridan E, Schmidts M, Olbrich H, Werner C, Häffner K, Hellman N, Chodhari R, Gupta A, Kramer-Zucker A, Olale F, Burdine RD, Schier AF, O'Callaghan C, Chung EM, Reinhardt R, Mitchison HM, King SM, Omran H, Drummond IA (2012) *CCDC103* mutations cause primary ciliary dyskinesia by disrupting assembly of ciliary dynein arms. *Nat Genet* 44:714-9
- Shoemark A, Moya E, Hirst RA, Patel MP, Robson EA, Hayward J, Scully J, Fassad MR, Lamb W, Schmidts M, Dixon M, Patel-King RS, Rogers AV, Turman A, Jackson CL, Goggin P, Rubbo B, Olsson S, Carr S, Walker W, Adler B, Loebinger MR, Wilson R, Bush A, Williams H, Bousted C, Jenkins L, Sheridan E, Chung EMK, Watson CM, Cullup T, Lucas JS, Kenia P, O'Callaghan C, King SM, Hogg C,

Mitchison HM. High prevalence of *CCDC103* p.His154Pro mutation causing primary ciliary dyskinesia disrupts protein oligomerisation and is associated with normal diagnostic investigations. *Thorax* 2018;73:157-166

Zariwala MA, Gee HY, Kurkowiak M, Al-Mutairi DA, Leigh MW, Hurd TW, Hjeij R, Dell SD, Chaki M, Dougherty GW, Adan M, Spear PC, Esteve-Rudd J, Loges NT, Rosenfeld M, Diaz KA, Olbrich H, Wolf WE, Sheridan E, Batten TF, Halbritter J, Porath JD, Kohl S, Lovric S, Hwang DY, Pittman JE, Burns KA, Ferkol TW, SageI SD, Olivier KN, Morgan LC, Werner C, Raidt J, Pennekamp P, Sun Z, Zhou W, Airik R, Natarajan S, Allen SJ, Amirav I, Wieczorek D, Landwehr K, Nielsen K, Schwerk N, Sertic J, Köhler G, Washburn J, Levy S, Fan S, Koerner-Rettberg C, Amselem S, Williams DS, Mitchell BJ, Drummond IA, Otto EA, Omran H, Knowles MR, Hildebrandt F. *ZMYND10* is mutated in primary ciliary dyskinesia and interacts with *LRRC6*. *Am J Hum Genet* 2013;93:336-45

Zietkiewicz E, Bukowy-Bieryllo Z, Rabiasz A, Daca-Roszak P, Wojda A, Voelkel K, Rutkiewicz E, Pogorzelski A, Rasteiro M, Witt M. *CFAP300*: mutations in Slavic primary ciliary dyskinesia patients and a role in ciliary dynein arms trafficking. *Am J Respir Cell Mol Biol* 2019;61:440-9.